

QUALITY ASSESSMENT OF RIVER'S WATER OF LUMBARDHI PEJA (KOSOVO)

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Abstract. The surface waters in Kosovo are predominately polluted, and it is evidential that domestic and industrial wastewaters treatment plants still don't exist in any of the cities in Kosovo. In this research work we have analyzed 67 elements in the water of Lumbardhi Peja. Results of some toxic elements are as: Cu ($4.0 - 13.5 \mu\text{g dm}^{-3}$), Zn ($7.1 - 34.1 \mu\text{g dm}^{-3}$), Pb ($0.8 - 4.32 \mu\text{g dm}^{-3}$), Cd ($0.15 - 0.07 \mu\text{g dm}^{-3}$), Mn ($2.7 - 120 \mu\text{g dm}^{-3}$), As ($0.18 - 0.71 \mu\text{g dm}^{-3}$), Cr ($0.5 - 1.5 \mu\text{g dm}^{-3}$), Fe ($30 - 760 \mu\text{g dm}^{-3}$), Ni ($1.3 - 19.5 \mu\text{g dm}^{-3}$), Sb ($0.05 - 0.1 \mu\text{g dm}^{-3}$), Al ($79 - 418 \mu\text{g dm}^{-3}$). Also some physico-chemical parameters are determined: air temperature, water temperature, pH, electrical conductivity (EC), total hardness, Cl^- , SO_4^{2-} , NO_3^- and NO_2^- . Results of some parameters and ecotoxic ions are as: Conductivity ($216-399 \mu\text{S cm}^{-1}$), pH (8.2-8.58), NO_2^- ($0.015-0.045 \text{ mg dm}^{-3}$), NO_3^- ($0.01-1.1 \text{ mg dm}^{-3}$), Cl^- ($1.55-2.95 \text{ mg dm}^{-3}$) and SO_4^{2-} ($4.2-9.2 \text{ mg dm}^{-3}$). Results obtained by the box plot method showed the regions with determined anomalous element concentration values in the water of Lumbardhi Peja. Even that in Kosovo we don't have yet any legislative convent for allowed concentrations of toxic metals for natural water resources, the results from this study are a small contribution to gain a clear overview of the statement in this field of environmental quality assurance.

Keywords: water, Lumbardhi River, pollution assessment, heavy metals, physico-chemical parameters, ICP/MS

Introduction

Water is an important constituent of all living organisms present on the Earth and has most significance for humans for adequate life.

Kosovo is regarded as place with developed river network. Its small size and dynamics of relief have not created circumstances that can form any major river flow. Kosovo has no navigable river, but existing rivers have been the deciding factor for the development of life, the establishment of settlements and communication links through their valleys.

Geographical position of the river Lumbardhi Peja (Fig. 1) has its origins from Mokna Mountains (Mountains humid) near Cakor Alps. One of its subsidiaries is lo-



Fig. 1. Lumbardhi Peja river

cated at an altitude of 1849 m above sea level and the other side has located at 2000 m above sea level. From its origins in the city of Peja, the river flows in a river bed which is long 34 km. The river Lumbardhi Peja is supplied by groundwater flows in the mountainous area that means from Bjeluha and Jezer on the right side and Boga, Drela and Alag on the left side (Fazliu, 2012).

Scarcity and misuse of fresh water pose a serious and growing threat to sustainable development and protection of the environment. Human health and welfare, food security, industrial development and the ecosystems on which they depend, are all at risk, unless water and land resources are managed more effectively in the present decade and beyond than they have been in the past.¹⁾

Overexploitation of nature and uncontrolled use of natural resources, including inadequate processing of industrial wastes have caused large contamination of world ecosystems by toxic metals (Hg, Pb, Cd, Cu, Zn, Ni, Mn). The major contaminates are metals and metalloids, which are causing the effect (Censi et al., 2006; Fernandes et al., 2008). They have the ability to bioaccumulates in organisms living in the water system (Arain et al., 2008; Pyle et al., 2005; Szymanowska et al., 1999). Studies on toxic metals and metalloids in lakes, rivers, groundwater and fishes have been the main

environmental focal points, particularly over the last decade (Christensen et al., 2006; Guggenmos et al., 2011; Peng et al., 2008; Sadiq et al., 2003; Issa et al., 1996).

Water quality monitoring has a high priority for the determination of current conditions and long term trends in effective management. The supply of unsafe water has a magnificent impact in the anticipation of water transmitted diseases.

Nowadays, determination of total quantitative and qualitative metals and distribution of all their physical and chemical forms in traces (speciation) in natural water equilibrium resources is to be considered as the main challenge for most of the scientists (Kester, 1975). Based on the results of such studies, it will be possible in the future to propose protection and detoxification measures of affected river waters and general protection and remediation of ecosystems. This work is a continuation of earlier studies of surface waters in Kosovo (Gashi et al., 2009; 2011; 2013; 2014; Faiku et al., 2011; 2014).

Materials and methods

Sampling and sample preparation

Samples were taken from along the banks of the sampling station on June 2013. Sampling tools were washed and dried with water before the next sample was collect-



Fig. 2. Study area with sampling stations

ed. Water samples were collected from surface waters below 10 cm (Gupta, 2009). The collected samples were stored in polythene plastic containers. Weather was cloudy and rainy, with middle water levels, which was very suitable for sampling. Extraction of champions and elaboration of samples were done according to standards methods for surface water²⁾ (Baba et al., 2003). The study area with the sampling locations is shown in Fig. 2 and the details about all sampling sites are presented in Table 1.

Table 1. The water sampling points in the River Lumbardhi Peja with detailed descriptions

Sampling point Pollutants	Location	Type of relief	The water level	Potential
L ₁	Haxhaj	Steep	The above	Agricultural land
L ₂	The city	Soft	The above	Traffic, agricultural land, wastewater
L ₃	Transit bridge	Soft	The above	Traffic, agricultural land, wastewater
L ₄	Near the bridge of Klina	Soft	The above	Traffic, agricultural land, wastewater

The numbers of sampling spots is 4 and in every sampling spot were taken samples in order to determine the chemical parameters. Each sampling spot of water in the river of Lumbardhi Peja, have been marked by codes L₁, L₂, L₃ and L₄.

Determination of physicochemical parameters

For determination of the quality water parameters we have used standard methods for water analyzes including classical and contemporary methods. Temperature of water was measured immediately after sampling, using digital thermometer, model “Quick 63142”. Measurements of pH were performed immediately after sampling using pH/ion-meter, model “Hanna Instruments, pH & EC”. Electric conductivity was measured by “HANNA Instrument HI 8424” conductivity meter. Total hardness of water was measured using chemicals of p.a. purity. Total hardness was determined by EDTA nitration using Mercurochrome black T indicator. Chlorides determined using argentimetric methods. Some of physic-chemical parameters (NH₄⁺, NO₃⁻, PO₄³⁻) were determined using UV-VIS spectrometer method. “WTW S12 Photometer”, “SECOMAM Prim Light spectrophotometer” and “SECOMAM Pastel UV RS232 spectro-

photometer" were used with a monochromatic irradiation in spectral range of 190-1100 nm. Its measurement region, in a caveat of 10 mm, was 340-800 nm, is dedicated for drinking waters analysis, discharged and sea water.

Determination of major and trace elements

We used the ICP/OES (Inductively coupled plasma in combination with optical emission spectrophotometer) method to determine the concentration of elements.

Statistical analysis

Program Statistica 6.0³⁾ was used in statistical calculations of this work, such as: determination of basic statistical parameters and two dimensional box plot diagrams for determination anomalies (extremes and outliers) for solution data.

Results and discussion

Physicochemical parameters

In Table 2 are shown several physico-chemical parameters measured in water of Lumbardhi Peja: water temperature, air temperature, electrical conductivity (EC), pH, total hardness, sulphates, nitrates, nitrites and chlorides.

Table 2.Physico-chemical parameters determined in river waters: water temperature, air temperature, electrical conductivity (EC), pH, total hardness, sulphates, nitrates, nitrites and chlorides

Parameters	Sampling point			
	L ₁	L ₂	L ₃	L ₄
Water temperature/ ° C	6.5	8.5	10	12.5
Air temperature/ ° c	26	26	26	26.2
ECκ/μS cm ⁻¹	216	236	283	399
pH	8.2	8.45	8.58	8.50
Total hardness/ °D	7.2	7.8	8.0	8.2
SO ₄ ²⁻ / mg dm ⁻³	6.2	4.2	6.4	9.2
NO ₃ ⁻ / mg dm ⁻³	0.01	0.042	0.55	1.1
NO ₂ ⁻ / mg dm ⁻³	0.015	0.019	0.031	0.045
Cl ⁻ / mg dm ⁻³	2.95	1.55	1.8	2.1

Temperature is an important biologically significant factor which plays an important role in the metabolic activities of organisms. It is also an important parameter in

determining water quality as it influences pH, alkalinity, acidity and Dissolved Oxygen (DO). The temperature values recorded in water samples from the study area ranges between 6.5 °C (L_1) and 12.5 °C (L_4) as summarized in Table 2 with mean temperature of 9.375 °C. Therefore, temperature values recorded were within the World Health Organization's standard for drinking water.⁴⁾

The pH is a measure of the intensity of acidity or alkalinity and measures the concentration of hydrogen ions in water. Basically, pH is determined by the amount of dissolved carbon dioxide (CO_2) which forms carbonic acid in the water. The pH values of the surface water sampled in the area varied from 8.20-8.58 as against the World Health Organization's standard range of 6.50-8.50 and with mean value of 8.433. From these data we can see that the water from the river Lumbardhi Peja is slightly basic.

Electrical Conductivity (EC) is a measure of water capacity to convey electric current. It is a determination of levels of inorganic constituents in water (Awofolu et al., 2007). EC values returned by the samples were in the range of 216-399 $\mu S\ cm^{-1}$. The highest conductivity was recorded in the sampling point L_4 while the lowest value was recorded at the sampling point L_1 . This increase in terms of river flow Lumbardhi Peja is added as a result of salts and other ingredients of water. The Electrical Conductivity (EC) from the analysis was below the WHO recommended value of 400 $\mu S\ cm^{-1}$ value indicating low amount of dissolved inorganic substances in ionized form.

The total hardness was 7.2 °D (sampling point L_1), 7.8 °D (sampling point L_2), 8.0 °D (sampling point L_3) and 8.20 °D (sampling point L_4). The lowest total hardness is observed at L_1 (7.2 °D) and the higher value of the hardness was observed at point L_4 (8.20 °D). From the results we can see that this water should consider as mild.

Sulphate content in excess of 100 $mg\ dm^{-3}$ tends to give water a bitter taste and has a laxative effect on people not adapted to the water (Ibrahim & Ajibade, 2012). Also ailments like catharsis, dehydration and gastrointestinal irritation have been linked with it when concentration is high. In the water samples analyzed the results revealed that all the water sampled have low sulphate content ranging from 4.2-9.2 $mg\ dm^{-3}$ (Table 2). So, the concentration of sulphates is below the maximum value allowed.^{4,5)}

Nitrate content in the water samples analyzed ranged from 0.01 $mg\ dm^{-3}$ in L_1 to 1.1 $mg\ dm^{-3}$ in L_7 . These fall within the allowable value, when compared with recommended guidelines.⁴⁾ Nitrate fouls the water system and epidemiological studies have shown that exposure to nitrate causes Methemoglobinemia disease (Adeyemo et al., 2002).

The amount of chloride and nitrites ions ranges from 1.55 -2.95 $mg\ dm^{-3}$ and 0.015-0.045 $mg\ dm^{-3}$, respectively. So, the concentration of these chemical parameters is below the maximum value allowed^{4,5)} with the exception of nitrates in the sampling points L_4 .

Concentration of major and trace elements

In Table 3 are shown concentrations of 67 elements in water of river Lumbardhi Peja.

Table 3. Concentrations ($\mu\text{g dm}^{-3}$) of 67 elements in water of the river Lumbardhi Peja

Element/ $\mu\text{g dm}^{-3}$	Sampling point			
	L ₁	L ₂	L ₃	L ₄
Na	560	598	925	1335
Li	<1	<1	1	1
Be	<0.1	<0.1	<0.1	<0.1
Mg	3560	2520	2630	3510
Al	115	79	90	418
Si	1400	1200	1200	2200
K	370	280	410	460
Ca	20000	20000	20000	20000
Sc	1	<1	<1	1
Ti	0.8	0.7	1.0	2.0
V	0.1	0.1	0.1	0.1
Cr	0.7	0.8	0.5	1.5
Mn	2.7	6.1	6.2	120
Fe	30	50	60	760
Co	0.04	0.04	0.1	1.20
Ni	3.5	1.3	4.2	19.5
Cu	4.0	10.5	4.2	13.5
Zn	34.1	13.1	7.1	13.8
Ga	0.01	0.02	0.02	0.1
Ge	<0.001	<0.01	<0.01	0.01
As	0.18	0.23	0.25	0.71
Se	<0.02	<0.02	<0.02	<0.02
Br	5	3	3	4
Rb	0.27	0.15	0.21	0.49
Sr	47.2	129	130	184
Y	0.08	0.09	0.08	0.08
Zr	0.02	0.02	0.01	0.04
Nb	0.005	0.005	0.005	0.005
Mo	<0.1	0.1	<0.1	<0.1

Ru	<0.01	<0.01	<0.01	<0.01
Pd	<0.01	<0.01	<0.01	<0.01
Ag	<0.2	<0.2	<0.2	<0.2
Cd	0.15	0.03	0.04	0.07
In	0.001	0.001	0.001	0.001
Sn	55	52	25	0.2
Sb	0.1	0.1	0.05	0.08
Te	<0.1	<0.1	<0.1	<0.1
I	2	1	1	1
Cs	0.01	0.02	0.02	0.03
Ba	20.1	15.1	14.4	30.1
La	0.04	0.05	0.04	0.60
Ce	0.11	0.14	0.12	1.50
Pr	0.015	0.025	0.025	0.23
Nd	0.04	0.06	0.05	0.93
Sm	0.022	0.032	0.022	0.35
Eu	0.01	0.01	0.02	0.08
Gd	0.01	0.02	0.02	0.32
Tb	<0.001	<0.001	<0.001	0.04
Dy	0.015	0.015	0.015	0.20
Ho	<0.001	<0.001	<0.001	<0.001
Er	0.01	0.01	0.01	0.11
Tm	<0.001	<0.001	<0.001	0.015
Yb	0.01	0.01	0.01	0.02
Lu	<0.001	<0.001	<0.001	0.01
Hf	0.01	0.01	0.01	<0.001
Ta	0.001	0.001	0.001	<0.001
S	<0.002	<0.002	<0.002	<0.002
Re	0.001	0.001	0.001	0.001
Os	0.002	0.002	0.002	0.002
Pt	<0.3	<0.3	<0.3	<0.3
Au	0.002	0.002	0.002	<0.002
Ti	<0.001	<0.001	<0.001	0.01
Pb	1.72	3.81	0.8	4.32
Bi	<0.3	<0.3	<0.3	<0.3
Th	0.001	<0.001	<0.001	0.018
U	0.06	0.10	0.10	0.24
Hg	<0.2	<0.2	<0.2	<0.2

The world health organization recommends that the zinc content of drinking water should not be greater than 3 mg dm^{-3} . Zinc concentration was observed to vary from $7.1\text{-}34.1 \text{ } \mu\text{g dm}^{-3}$ with a mean of $17.03 \text{ } \mu\text{g dm}^{-3}$ (Table 4) for all the samples. Zinc concentration in the water samples is under the WHO guideline.

The sodium content ranged from a minimum of $560 \text{ } \mu\text{g dm}^{-3}$ to a maximum $1335 \text{ } \mu\text{g dm}^{-3}$ respectively. The minimum values of samples can be explained on the basis of lower microbial activity. No limit is established⁴ for drinking water but a maximum standard of 100 mg dm^{-3} has been proposed for general public.

The major source of potassium in natural fresh water is weathering of rocks (Narayan et al., 2013). Potassium content in the water samples varied from $280\text{-}460 \text{ } \mu\text{g dm}^{-3}$. No guide and acceptable limits have been specified for potassium levels in the WHO standards for drinking water.

Magnesium ions are directly related to hardness. Magnesium content in the investigated water samples was ranging from $2520\text{-}3560 \text{ } \mu\text{g dm}^{-3}$ which are below the WHO guidelines of 200 mg dm^{-3} . It is known that Ca^{2+} and Mg^{2+} ions in water are essential for human health and metabolism metabolism (Kortatsi, 2007).

Most groundwater supplies contain some iron because it is one of the most abundant metals in the earth crust and is essential for plant and human being. But excess iron in drinking water produces inky taste and muddy smell. The world health organization recommends that the iron content of drinking water should not be greater than 0.2 mg dm^{-3} because iron in water stains plumbing fixtures, cloths during laundering, incrusts well screens and clogs pipes (Maureen et al., 2012). Iron concentration was observed to vary from $30\text{-}760 \text{ } \mu\text{g dm}^{-3}$ with a mean of $225 \text{ } \mu\text{g dm}^{-3}$ (Table 4) for all the samples. Iron concentration in the water sample L_4 is above the EU guideline.⁵

Cadmium level in all the samples were in the range of $0.03\text{-}0.15 \text{ } \mu\text{g dm}^{-3}$ with a mean value of $0.07 \text{ } \mu\text{g dm}^{-3}$ (Table 4). Relative cadmium concentration for individual samples is indicated in Table 3. L_2 has the least cadmium content and L_1 has the highest. In the case of cadmium the highest concentration was recorded at the sampling point L_1 ($0.15 \text{ } \mu\text{g dm}^{-3}$), where this high concentration comes from the face of the earth geology. The values are lower than the WHO recommended standard of $3 \times 10^{-3} \text{ mg dm}^{-3}$. Excess cadmium concentration in water is highly toxic and is responsible for adverse renal arterial changes in kidneys (Sanjoy& Rakesh., 2013).

Copper detected in the water samples very low and far below the recommended limits of 2.0 mg dm^{-3} set by the World Health Organization.⁴ Copper concentration was observed to vary from $4.0\text{-}13.5 \text{ } \mu\text{g dm}^{-3}$ with a mean of $8.05 \text{ } \mu\text{g dm}^{-3}$ (Table 4) for all the samples.

Lead level in all the samples were in the range of $0.8\text{-}3.81 \text{ } \mu\text{g dm}^{-3}$ with a mean value of $2.66 \text{ } \mu\text{g dm}^{-3}$ (Table 4). Relative lead concentration for individual samples is

also indicated in Table 3. L_3 has the least lead content and L_2 has the highest. The World Health Organization has recommended 0.01 mg dm^{-3} .⁴⁾ The values are lower than the recommended standard of 0.01 mg dm^{-3} .⁴⁾

Aluminum level in all the samples were in the range of $115\text{--}418 \text{ } \mu\text{g dm}^{-3}$ with a mean value of $175.50 \text{ } \mu\text{g dm}^{-3}$ (Table 4). Relative aluminum concentration for individual samples is indicated in Table 3. The world health organization recommends that the aluminum content of drinking water should not be greater than 0.2 mg . Aluminum concentrations in the water sample L_4 is above the WHO guideline.

Antimony ranges from $0.05 \text{ } \mu\text{g dm}^{-3}$ (L_4) to $0.1 \text{ } \mu\text{g dm}^{-3}$ (L_1 and L_2), barium ranges from $14.4 \text{ } \mu\text{g dm}^{-3}$ (L_3) to $30.1 \text{ } \mu\text{g dm}^{-3}$ (L_4), bromium ranges from $3 \text{ } \mu\text{g dm}^{-3}$ (L_2 and L_3) to $4 \text{ } \mu\text{g dm}^{-3}$ (L_4), chrome ranges from $0.5 \text{ } \mu\text{g dm}^{-3}$ (L_3) to $1.5 \text{ } \mu\text{g dm}^{-3}$ (L_4), manganese ranges from $2.7 \text{ } \mu\text{g dm}^{-3}$ (L_1) to $120 \text{ } \mu\text{g dm}^{-3}$ (L_4), nickel ranges from $1.3 \text{ } \mu\text{g dm}^{-3}$ (L_2) to $19.5 \text{ } \mu\text{g dm}^{-3}$ (L_4) and uranium ranges from $0.06 \text{ } \mu\text{g dm}^{-3}$ (L_1) to $0.24 \text{ } \mu\text{g dm}^{-3}$ (L_4). So, the concentration of these elements is below the maximum value allowed.⁴⁾

The data from the Table 3 shows that the concentrations of the elements beryllium, germanium, selenium, palladium, silver, tellurium, sulfur, platinum and bismuth are below the limit of the detection.

Results of heavy metals show us that their concentrations are within the standard rules, except for some sample places where we have the increasing concentration of some heavy metals. Removing heavy metals from surface water is important. Metals, as Cu^{2+} , Hg^{2+} , Pb^{2+} , Zn^{2+} , Ni^{2+} , Cd^{2+} , represent a harmful and noxious water contamination for human and animal consumption, mostly due to their tendency to be accumulated in the food chain. Their removal can be done with chemical precipitation, coagulation and flocculation, adsorption onto plant wastes and special treatments, as nanofiltration or reverse osmosis.

So these kind of waters before being used for human utilization must be treated by intensive physical and chemical treatment, extended treatment and disinfection, e.g., chlorination to break-point, coagulation, flocculation, decantation, filtration, adsorption (activated carbon), disinfection (ozone, final chlorination). The vulnerability of water quality is followed by serious changes of its properties, resulting undesirable effects, like: lack of oxygen, reduction in pH value, increase of heavy metal complexation capacity, increase of toxicity and hazardous substances accumulated in the food chain. Water resources in Kosovo are limited and the major ingredients of surface water are rivers excepting of some artificial accumulation lakes.

Global concern for environment, in spite of fact that efforts were done and are being done to overcome it, permanent monitoring of polluted waters with pollutants now and in the future will be a big challenge for us and all scientific institution entire Kosovo. Water like a natural resource with general interest, should be rationally used and it must be protected from eventual degradation.

Determination of basic statistical parameters

Table 4 presents basic statistical parameters for 67 elements in four samples, which can be considered as preliminary values until a larger dataset has been collected. For each element, the values are given as arithmetic mean, geometric mean, median, minimal and maximal concentration, standard deviation, skewness and kurtosis.

Table 4. Basic statistical parameters for four major and 67 minor elements in samples of river Lumbardhi Peja

	Descriptive Statistics								
	Mean	Geometric	Median	Minimum	Maximum	Variance	Std. Dev.	Skewness	Kurtosis
Na	854.50	801.91	761.50	560.00	1335.00	129457.7	359.8023	0.98571	-0.53582
Li	1.00	1.00	1.00	1.00	1.00	0.0	0.0000	-	-
Be	0.10	0.10	0.10	0.10	0.10	0.0	0.0000	-	-
Mg	3055.00	3016.67	3070.00	2520.00	3560.00	309633.3	556.4471	-0.02674	-5.76589
Al	175.50	135.97	102.50	79.00	418.00	26363.0	162.3669	1.94922	3.82225
Si	1500.00	1451.20	1300.00	1200.00	2200.00	226666.7	476.0952	1.77918	3.13495
K	380.00	373.87	390.00	280.00	460.00	5800.0	76.1577	-0.69728	0.54875
Ca	20000.00	20000.00	20000.00	20000.00	20000.00	0.0	0.0000	-	-
Sc	1.00	1.00	1.00	1.00	1.00	0.0	0.0000	-	-
Ti	1.13	1.03	0.90	0.70	2.00	0.4	0.5965	1.74903	3.09087
V	0.10	0.10	0.10	0.10	0.10	0.0	0.0000		
Cr	0.88	0.81	0.75	0.50	1.50	0.2	0.4349	1.50411	2.64620
Mn	33.75	10.52	6.15	2.70	120.00	3308.9	57.5230	1.99517	3.98433
Fe	225.00	90.94	55.00	30.00	760.00	127366.7	356.8847	1.99264	3.97593
Co	0.35	0.12	0.07	0.04	1.20	0.3	0.5707	1.98545	3.94926
Ni	8.78	4.73	3.85	1.30	26.10	134.9	11.6159	1.93110	3.78889
Cu	8.05	6.99	7.35	4.00	13.50	22.3	4.7233	0.33586	-4.07722
Zn	17.03	14.46	13.45	7.10	34.10	138.6	11.7738	1.59574	2.98844
Ga	0.04	0.03	0.02	0.01	0.10	0.0	0.0419	1.92252	3.77000
Ge	0.01	0.01	0.01	0.01	0.01	0.0	0.0000	-	-
As	0.34	0.29	0.24	0.18	0.71	0.1	0.2468	1.91346	3.73475
Se	0.02	0.02	0.02	0.02	0.02	0.0	0.0000	-	-
Br	3.75	3.66	3.50	3.00	5.00	0.9	0.9574	0.85456	-1.28926
Rb	0.28	0.25	0.24	0.15	0.49	0.0	0.1483	1.37292	2.02645
Sr	122.55	109.86	129.50	47.20	184.00	3183.6	56.4235	-0.72403	1.79270
Y	0.08	0.08	0.08	0.08	0.09	0.0	0.0050	2.00000	4.00000
Zr	0.02	0.02	0.02	0.01	0.04	0.0	0.0126	1.12934	2.22715
Nb	0.01	0.01	0.01	0.01	0.01	0.0	0.0000	-	-

Mo	0.10	0.10	0.10	0.10	0.10	0.0	0.0000	-	-
Ru	101.00	101.00	101.00	101.00	101.00	0.0	0.0000	-	-
Pd	0.01	0.01	0.01	0.01	0.01	0.0	0.0000	-	-
Ag	0.20	0.20	0.20	0.20	0.20	0.0	0.0000	-	-
Cd	0.07	0.06	0.06	0.03	0.15	0.0	0.0544	1.46825	1.90772
In	0.00	0.00	0.00	0.00	0.00	0.0	0.0000	-	-
Sn	33.05	10.94	38.50	0.20	55.00	661.6	25.7218	-0.72827	-1.85050
Sb	0.08	0.08	0.09	0.05	0.10	0.0	0.0236	-1.19382	0.43573
Te	0.10	0.10	0.10	0.10	0.10	0.0	0.0000	-	-
I	1.25	1.19	1.00	1.00	2.00	0.3	0.5000	2.00000	4.00000
Cs	0.02	0.02	0.02	0.01	0.03	0.0	0.0082	0.00000	1.50000
Ba	19.93	19.04	17.60	14.40	30.10	52.5	7.2426	1.35546	1.26999
La	0.18	0.08	0.04	0.04	0.60	0.1	0.2784	1.99829	3.99420
Ce	0.47	0.23	0.13	0.11	1.50	0.5	0.6884	1.99804	3.99339
Pr	0.07	0.04	0.03	0.01	0.23	0.0	0.1043	1.98762	3.96050
Nd	0.27	0.10	0.06	0.04	0.93	0.2	0.4401	1.99793	3.99312
Sm	0.11	0.05	0.03	0.02	0.35	0.0	0.1624	1.99498	3.98282
Eu	0.03	0.02	0.01	0.01	0.08	0.0	0.0337	1.88710	3.57612
Gd	0.09	0.03	0.02	0.01	0.32	0.0	0.1517	1.99417	3.98114
Tb	0.01	0.00	0.00	0.00	0.04	0.0	0.0195	2.00000	4.00000
Dy	0.06	0.03	0.01	0.01	0.20	0.0	0.0925	2.00000	4.00000
Ho	0.00	0.00	0.00	0.00	0.00	0.0	0.0000	-	-
Er	0.04	0.02	0.01	0.01	0.11	0.0	0.0500	2.00000	4.00000
Tm	0.00	0.00	0.00	0.00	0.01	0.0	0.0070	2.00000	4.00000
Yb	0.01	0.01	0.01	0.01	0.02	0.0	0.0050	2.00000	4.00000
Lu	0.00	0.00	0.00	0.00	0.01	0.0	0.0045	2.00000	4.00000
Hf	0.01	0.01	0.01	0.00	0.01	0.0	0.0045	-2.00000	4.00000
Ta	0.00	0.00	0.00	0.00	0.00	0.0	0.0000	-	-
S	0.00	0.00	0.00	0.00	0.00	0.0	0.0000	-	-
Re	0.00	0.00	0.00	0.00	0.00	0.0	0.0000	-	-
Os	0.00	0.00	0.00	0.00	0.00	0.0	0.0000	-	-
Pt	0.30	0.30	0.30	0.30	0.30	0.0	0.0000	-	-
Au	0.00	0.00	0.00	0.00	0.00	0.0	0.0000	-	-
Hg	0.20	0.20	0.20	0.20	0.20	0.0	0.0000	-	-
Tl	0.00	0.00	0.00	0.00	0.01	0.0	0.0045	2.00000	4.00000
Pb	2.66	2.18	2.77	0.80	4.32	2.8	1.6754	-0.17484	-4.14949
Bi	0.30	0.30	0.30	0.30	0.30	0.0	0.0000	-	-
Th	0.01	0.00	0.00	0.00	0.02	0.0	0.0085	2.00000	4.00000
U	0.13	0.11	0.10	0.06	0.24	0.0	0.0790	1.64590	3.10321

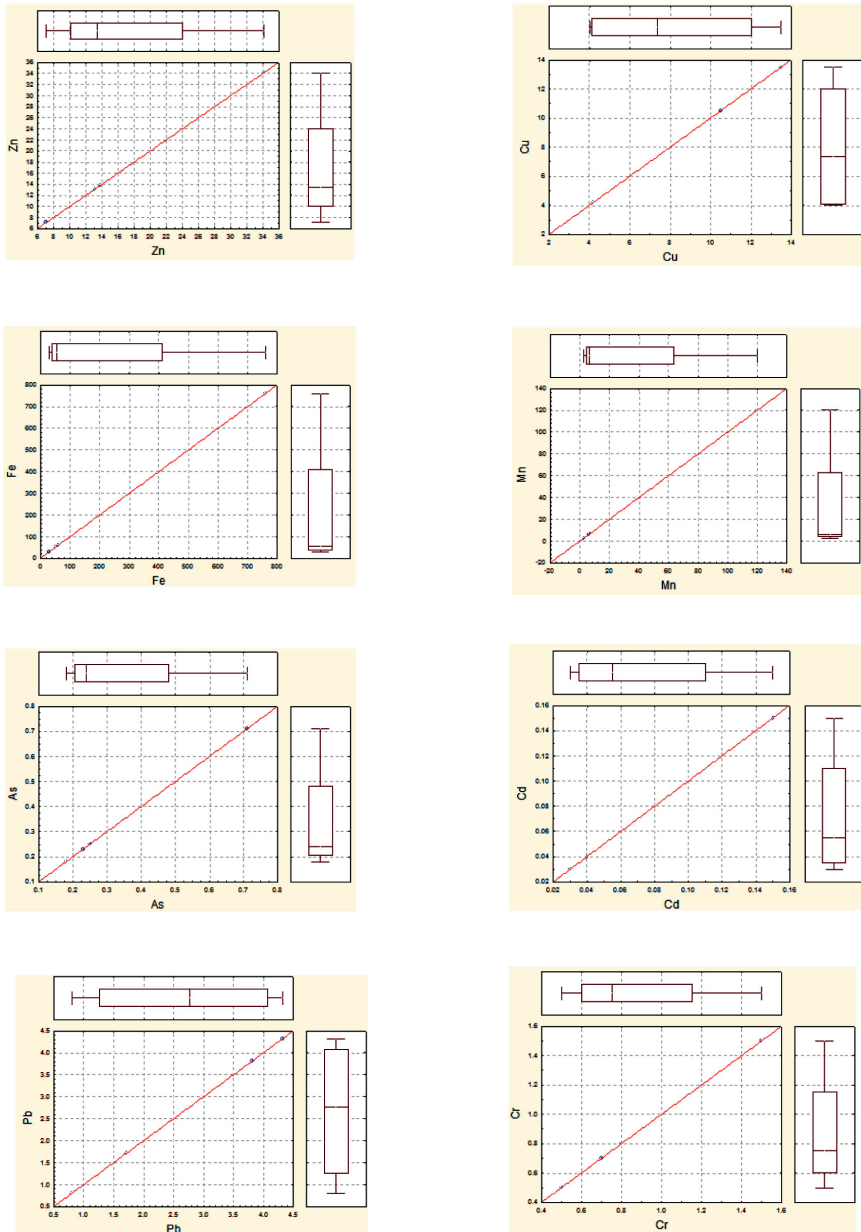


Fig. 3. Scatter/box two dimensional diagrams for arsenic, copper, cadmium, zinc, lead, iron, manganese and chromium

From experimental data (Table 3) and box plot approach of Tukey (1977), we have determined the abnormal date (extremes and outliers) for some elements in river Lumbardhi Peja.

In Fig. 3 are shown the Scatter/box two dimensional diagrams for heavy metals arsenic, copper, cadmium, zinc, lead, iron, manganese and chromium in river Lumbardhi Peja samples. Arsenic, copper, cadmium, zinc, lead, iron, manganese and chromium do not show any extreme and outlier in water samples.

In Kosovo we do not have standards yet, so we decided to use the Croatian standards to classify the water quality of the river Lumbardhi Peja.⁶⁾

In Table 5 are shown the classifications of water samples of the Lumbardhi Peja, based on the concentrations of toxic metals.

Table 5. Classification of water Lumbardhi Peja based on some trace metals as pollutant indicator

Metal/ $\mu\text{g dm}^{-3}$	Water class				
	I	II	III	IV	V
Cu	<2	2-10	10-15	15-20	>20
Zn	<50 L_1, L_2, L_3, L_4	L_1, L_3 50-80	L_2, L_4 80-100	100-200	>200
Pb	<0.1	0.1-2.0 L_1, L_3	2.0-5.0 L_2, L_4	5.0-80	>80
Cd	<0.1 L_1, L_2, L_3, L_4	0.1-0.5	0.5-2.0	2.0-5.0	>5.0

Based on Croatian standards for drinking water, the water from the river Lumbardhi Peja was classified in first class (no anthropogenic pollutions)-according to the concentrations of zinc and cadmium. According to the concentration of cuprum and lead, the water was classified in the second (the concentration of toxic metals are more pronounced than usual concentrations of their natural) and third class (the toxic metal concentrations are lower than those of their permanent level).

Conclusion

Based on our results we can conclude:

- (1) Our analyses about water of the river called Lumbardhi of Peja relate that water quality is good, except in some sample places where they appear like anthropogenic pollutants.
- (2) Results of heavy metals show us that their concentrations are within the standard rules, except for some sample places where we have the increasing concentration of

some heavy metals. The heavy metals like copper, nickel, manganese, zinc, lead, cadmium, chrome and antimony in water samples of the Lumbardhi Prizren are within the World Health Organization's recommended value.

(3) The alkaline earth metals like calcium, magnesium, sodium, barium, potassium, and lithium in water of the Lumbardhi Prizren are within permissible limits of the World Health Organization. The chlorides, sulphates, nitrates, nitrites, pH and electrical conductivity are within the WHO recommended value.

(4) According to pH the water is basic (pH=8.2-8.58).

(5) According to hardness the water is more or less mild (7.2-8.2 °D).

(6) Based on Croatian standards for drinking water, the Lumbardhi water was classified in first class according to the concentrations of zinc and cadmium.

(7) Based on Croatian standards for drinking water, the Lumbardhi water was classified in the second and third class, according to the concentration of cuprum and lead.

(8) Even that in Kosovo we do not have yet any legislative convent for allowed concentrations of toxic metals for natural water resources, the results from this study are a small contribution to gain a clear overview of the statement in this field of environmental quality assurance. We have concluded that water resources of Kosovo's are endangered by the pollution caused by human bean. As first step further, surface water pollution has to be stopped and to improve the existing condition. It is necessary prevention, monitoring and reduce of scale pollution, to ensure the quality level, biological equilibrium and these water ecosystem and at those places where quality rehabilitation is possible. We are very concerned about these facts but we hope that is still time to prevent the quality of Kosovo's surface waters.

NOTES

1. Agenda 21: Governments at the United Nations Conference on Environment and Development (UNCED), Rio de Janeiro, 1997.
2. Standard methods for the examination of water and wastewater, Washington, 2005.
3. Stat Soft, Inc. Statistica (data analysis software system), version 6, 2001.
4. World Health Organization: Guidelines for drinking water quality, Geneva, 1993.
5. EU's drinking water standards, Council Directive 98/83/EC on the quality of water intended for human consumption: adopted by the Council, on 3 November 1998.
6. Directive about water classification (in Croatian, legislative act). *Narodne Novine*, 107/95, 1998.

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